CALF REARING

GRICULTURE, FISHERIES AND FOOD

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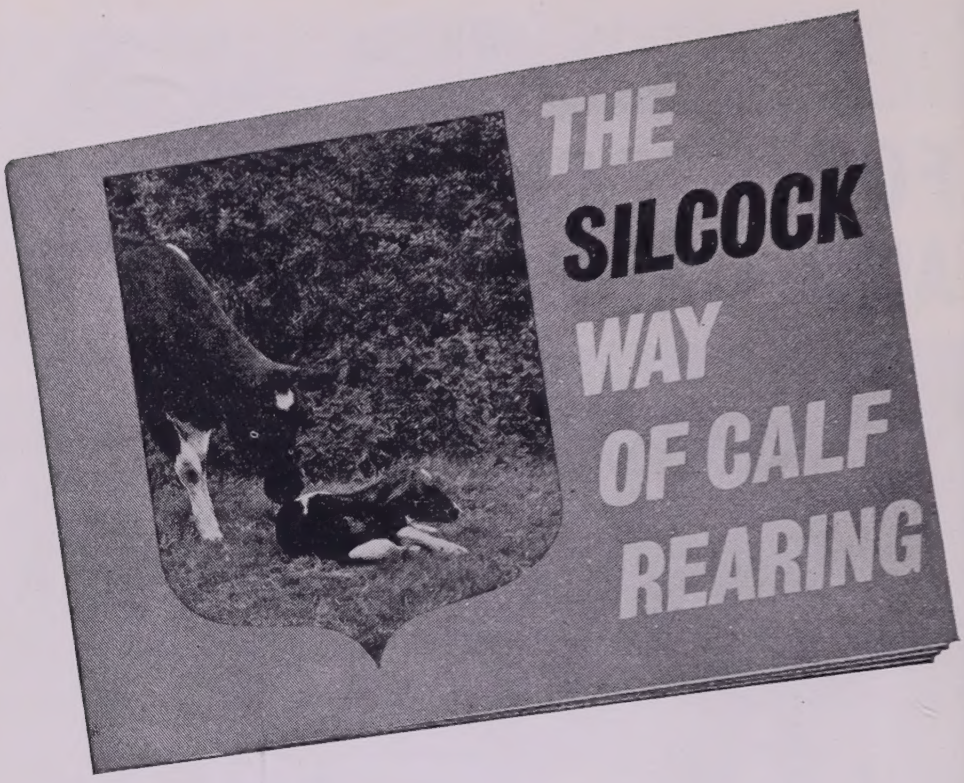

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MINISTRY OF
AGRICULTURE, FISHERIES AND FOOD

Calf Rearing

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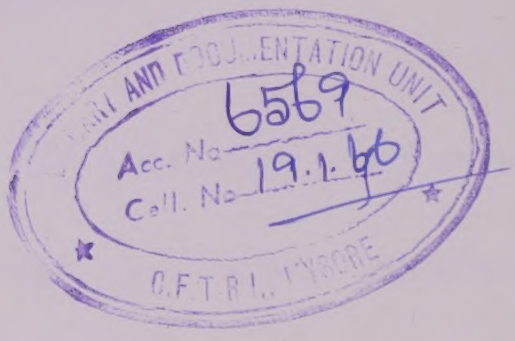

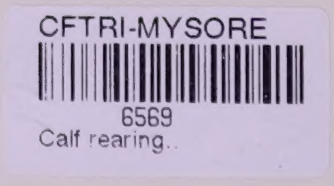

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Foreword

CALF rearing has in the past been rather an empirical business in which the rearer has imitated the cow, feeding liberal quantities of milk or, more niggardly, skim milk or liquid feeds compounded from dairy by-products. In general it has been held that the more milk or milk substitute a calf got the better it was likely to thrive.

Research on the physiology of the young calf has not wholly supported this view. The calf is a resilient and adaptable animal. It can be schooled to thrive on diets which would hitherto have been considered quite unsuitable, provided certain precautions are observed.

The present edition of the bulletin—the fourth—has been written by Dr. T. R. Preston of the Rowett Research Institute. In it he traces the bearing of his own studies and those of numerous other workers on existing practice and shows how the latter can be modified.

I should like, on behalf of the Ministry, to thank him for the service he has rendered and to commend this new review of an old subject to all concerned in the management of calves.

J. A. MCMILLAN
Director
National Agricultural Advisory Service

Ministry of Agriculture, Fisheries and Food
October 1960

CHAPTER I

Nutritive Requirements of the Calf

Feeding the In-calf Cow

The diet of the in-calf cow has comparatively little effect on the size and vigour of the calf at birth unless there is a gross deficiency of one of the major nutrients, but it does influence the yield and composition of the milk produced at calving. In dairy herds only a small proportion of the milk produced is used for the rearing of calves and the feeding of the pregnant dairy cow is therefore governed more by the requirements for economic milk production than the needs of the calf. On the other hand, in some suckling beef herds the winter rations are of such poor quality that it may be good practice to increase the level of feeding during the last two months of pregnancy since this will increase the milk yield of the cow after calving and thus accelerate the growth of her calf. Muscular dystrophy due to vitamin E deficiency has been reported in suckling beef calves whose dams are fed during the greater part of gestation on vitamin-low rations such as oat straw and swedes. Incorporating green foods such as silage and dried grass in the prepartum diet increases the vitamin E content of the colostrum and milk and will help to prevent this condition.(2)

Nutrition of the Young Calf

To rear the calf well and economically it is necessary to know its nutritive requirements and to understand the mechanisms of digestion in what is, in fact, a developing ruminant.

Colostrum

Like the pig, but unlike the human, the calf depends upon antibodies secreted in colostrum to give it protection against some infectious diseases. The cow's placenta is impervious to antibodies and moreover these substances can only pass into the blood during the first 24–36 hours of life. It is therefore extremely important that the calf should be fed colostrum during this period. Colostrum is normally rich in the fat soluble vitamins A, D and E and in carotene which is a precursor of vitamin A; it contains a greater proportion of the more easily digested proteins than does normal cows' milk and is slightly laxative.

Digestion in the young calf

The nutritional requirements of the calf between 3 days and 12 weeks old depend on the method of feeding, and particularly on whether the calf is fed a liquid or a solid diet. Functionally the calf can be considered to have two stomachs—the rumen, or paunch, and then the true stomach, or abomasum, which corresponds to the stomach in simple-stomached animals like the pig and the rat.

When a liquid food such as milk or a reconstituted milk replacement is fed the lips of the rumen are drawn up to form a channel, called the oesophageal groove, and this carries the food directly into the abomasum and thence

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to the small intestine. Digestion of such foods is mainly brought about by enzymes in the gastric juice secreted from glands leading into these parts of the digestive tract. On the other hand, solid foods, such as concentrates and hay, do not induce formation of the oesophageal groove and thus pass first into the rumen where they are fermented and mainly digested by bacteria and other micro-organisms. Efficient utilization of a liquid food depends therefore on whether the animal possesses the appropriate enzymes to digest it, while utilization of hay and concentrates is governed by the degree of development of the rumen and its microflora.

Liquid foods

It is obvious that the calf has enzymes capable of digesting casein, lactose and butterfat since these are the main constituents of cows' milk. But it has been shown by recent research work that during the first 4 weeks of life the ability of the calf to use other foods is very limited.

Results of recent research at the National Institute for Research in Dairying([6]) indicate that the only carbohydrate, other than lactose, which can be digested by the young calf when fed in a liquid diet, is glucose. In particular, starch, which is the cheapest and most commonly used source of energy in our livestock feeds, cannot be utilized at all when incorporated in a liquid food. In fact its inclusion in the liquid diet of the very young calf may be a liability, since it passes down the gut undigested, provides a source of food for bacteria normally resident in the colon and the resultant increased bacterial activity there is frequently the cause of scour or diarrhoea([1]). Once the calf reaches the age of 4–6 weeks its tolerance to starch and other carbohydrates, such as maltose and sucrose, increases but under this age it should never be fed a liquid diet containing these foods.

The problem with regard to the utilization of fat by the young calf is largely a mechanical one since the diameter of the globules must be reduced to a very small size before they can be absorbed from the gut. Emulsifying agents and homogenizing equipment are necessary to achieve this and as these are not available on the commercial farm the problem is largely one for the food manufacturer. While some fat as a source of essential fatty acids is essential in the diet of the young calf, the amount required is small and will be supplied adequately in the milk products on which liquid diets must be based. There is some risk in using cod liver oil in a liquid diet in view of the high incidence of muscular dystrophy amongst calves fed more than 1 oz per day of this product.([5])

In the first week of life the calf is dependent on the action of rennet for the initial stages of protein digestion. This enzyme has little effect on any protein other than casein (the main protein in cows' milk) and because casein occurs naturally only in milk there is little point in considering any sources of protein except milk and milk by-products.

It will be apparent from this brief review of the calf's requirements for the major nutrients that in liquid diets these can be met only by feeding milk or milk by-products. Fresh separated milk is the best alternative to whole cows' milk, but this is available on only a small proportion of farms. Dried buttermilk and dried skim milk reconstituted with warm water are the next most suitable; whey does not contain sufficient protein and on account of its very high lactose content is likely to cause diarrhoea. Buttermilk contains

more fat than skim milk and is to be preferred for this reason, although dried skim milk is more readily available.

Dry foods

So far the calf's requirements have been considered in relation to the feeding of liquids, for which the mode of digestion is similar to that in simple-stomached animals. From a nutritional point of view, this method of digestion is more efficient than that in the adult ruminant but, when assessed on the basis of economics, the calf is at a disadvantage since diets suitable for feeding as liquids must be composed of whole milk or reconstituted dried milk by-products. In these foods the cost per unit of starch equivalent can be as much as 12–15 pence. On the other hand, an animal with a functional rumen can be fed diets costing only 3–6 pence per unit of starch equivalent, hence the sooner it reaches this state the more cheaply it can be fed.

The rumen increases in size slightly while the calf is being fed milk, but the major stimulus to its development is the ingestion of solid food such as concentrates and hay. It was once thought that the physical texture, i.e., the fibrousness, of the diet was primarily responsible for rumen development, but it has since been shown that chemical substances liberated by bacterial breakdown of the food are the main stimuli for this growth of rumen tissue.[23]

Small quantities of food, such as straw and milk, begin to collect in the rumen in the first few days of life and on this substrate there develops a characteristic flora of micro-organisms. Products of fermentation by these organisms have been detected in the rumen soon after birth and these processes are accelerated once the calf begins to eat solid food. Rumination in calves encouraged to eat dry food early has been noted in the second week of life and by 3 weeks the rumen can be considered fully functional as compared with that of the adult. In theory therefore it should be possible to feed the 3 week old calf as if it were an adult ruminant with all the attendant advantages of microbial synthesis of protein and B vitamins from simple food constituents. Moreover, starch, which has no food value to the calf when fed as a constituent of a liquid diet for reasons stated earlier, when incorporated into a solid diet such as concentrates, is fermented in the rumen by bacteria to acids which can be utilized directly as sources of energy. Similarly, proteins from groundnut and soya bean meal, which if fed in a liquid diet would be of low biological value, after being exposed to bacterial action in the rumen are converted to bacterial protein which has a high biological value.

It is obvious that artificial diets which are to be fed dry are much cheaper than synthetic liquid diets, since the former can be based on foods normally fed to adult cattle while the latter must be compounded from expensive milk by-products. There are added advantages in favour of dry diets in that they require less labour to prepare and feed, and there is a virtual absence of scouring.

The difficulty with dry diets is that they are much less attractive to the calf than liquid diets. There is in fact a minimum age before which the calf will not eat sufficient dry food to maintain growth and for the very early phase of the calf's life a liquid diet is essential. But provided such liquid feeding is restricted slightly, calves will usually begin to eat concentrates at the age of 2 weeks and by 3–5 weeks the majority can be weaned off liquid food completely. There is a slight check period following weaning, but then

the calf begins to eat increasing quantities of food and subsequent growth is very rapid and more than compensates for the poor rate of gain earlier.

Such a system of rearing has been developed at the Rowett Research Institute where it has been shown that calves make adequate growth when weaned from milk at 3 weeks old and subsequently fed a dry meal mixture, hay and water.[12]

The post weaning requirements of the early weaned calf are still under review but certain facts have been established. Palatability is the most important criterion of an early weaning concentrate and flaked maize and molasses are valuable ingredients in this context. The concentrate should be coarse-textured and finely ground particles should be kept to a minimum. In general, a pelleted feed is not as attractive to very young calves as a coarse meal; on the other hand, pellets are easier to handle and are less wasteful.

To produce a liveweight gain of up to 1 lb per day, an early weaning concentrate should have a crude protein : starch equivalent ration of 1:4, i.e., a mixture with a starch equivalent of 68 should contain 17 per cent crude protein. For expected liveweight gains of $1\frac{1}{2}$ lb per day a ratio of $1 : 3\frac{1}{2}$ is probably required.

The criteria for a good protein for early weaning diets are a low solubility and a high biological value. There is a highly significant improvement in nitrogen retention and in growth rate when 40 per cent of the protein in the diet is from fish meal rather than from groundnut meal.[14]

Recent work at the Rowett Research Institute indicates that fat, in the form of tallow, may be a worthwhile addition to early weaning concentrates. Tallow added to the concentrate to give a final concentration of 5 per cent appears to have the dual advantage of increasing the energy content and, by decreasing the dustiness, improving palatability. The net result of this addition has been an improvement of approximately 10 per cent in growth rate and food conversion rate during the period birth to 3 months; while during the first 4 weeks, which is the most critical time for early weaned calves, the increase in growth rate has been of the order of 30 per cent[14]. It is not easy to incorporate tallow in a ration with conventional farm mixing equipment since the fat must be melted first. But, if requested, an agricultural merchant would probably supply a premix of tallow and the protein concentrate in the ratio of 1 part tallow to 4 parts concentrate. Such a premix is easily incorporated with the remainder of the ingredients either by hand or in a standard mixer.

N.B. Only a high grade stabilized tallow with less than 1 per cent of free fatty acids should be used.

Vitamins and Minerals

A deficiency of calcium or phosphorus or vitamin D causes rickets, the symptoms of which include loss of appetite, swollen and stiff joints, bent forelegs and an arched back. Lack of vitamin A lowers the calf's resistance to infection. Watery eyes, nasal discharge, scouring and eventually night blindness are indications of a deficiency of this vitamin. The other important vitamin for the calf is vitamin E, a deficiency of which leads to muscular dystrophy. This condition is characterized by difficulty in walking and standing and general weakening of the musculature.

In practice B vitamins are never deficient in the calf's diet since colostrum contains quite large amounts and later they are synthesized by micro-organisms in the rumen.

Of the trace minerals magnesium, iron, copper and manganese are deficient in milk products but, as these elements are present in appreciable amounts in concentrates and roughages, deficiencies are not likely to occur.

In theory the vitamin and mineral requirements of the calf are supplied initially by colostrum and later by roughage. But, in view of the variability in quality of roughage, it is a wise precaution to supplement all concentrates fed to calves less than 6 months old with vitamins A and D, and with minerals.

In particular it should be noted that dried grass, although high in carotene which is a precursor of vitamin A, is low in vitamin D. At the Rowett Research Institute rickets have been induced in calves by feeding them on unsupplemented concentrates and dried grass to appetite.[11]

Suggested rates of addition are 4 million i.u. vitamin A, 1 million i.u. vitamin D and 36 lb minerals (equal parts limestone, sterilized bone meal and salt) per ton of concentrate.

Calves reared on pasture rarely require supplementary minerals or vitamins.

Antibiotics

The sale of antibiotics* for use in calf rearing is permissible only for scientific investigations or, on the farm, under veterinary prescription. But a great deal of investigational work has been carried out on the effects of antibiotics in calf rearing and readers may be interested in the general findings of researches on this subject.

It has been known for a long time that low level feeding of certain antibiotics, particularly chlortetracycline (aureomycin) and oxytetracycline (terramycin), to calves increases their appetite, their rate of growth and the efficiency with which they utilize food. Such treatment is also reported to decrease the incidence and severity of scours.[10]

It was thought at one time that the growth-stimulating properties of antibiotics were due entirely to their prophylactic effect in reducing the incidence and severity of sub-clinical disease. But recent findings suggest that, in early weaned calves at least, the main effect of incorporating an antibiotic in the concentrate mixture is to reduce fermentation in the rumen and that this results in increased appetite, better food conversion efficiency and more rapid growth.[17]

Apart from its growth promoting properties, it has been shown that chlortetracycline, fed at the rate of 250 mg daily for 16 days, will bring about a significant reduction in mortality even amongst calves deprived of colostrum and reared in highly infectious premises.[8, 20]

On the other hand, there is evidence that routine use of antibiotics for livestock leads to the emergence of strains of pathogens which are resistant to the particular antibiotics used.

* The Therapeutic Substances Act, 1956, and regulations made thereunder limit sales to those required for medical or veterinary prescriptions and scientific investigations, except in the case of pig and poultry foods which may contain specific quantities, subject to labelling requirements about, among other things, storage and use. In administering the provisions on the label the Ministry, on the advice of the Agricultural Research Council, refuses to approve labels advocating the feeding of antibiotics to breeding stock and laying birds.

Theory of feeding

The nutritional requirements of the calf can be summarized in practical terms as follows:

1. Liquid diets are much more palatable than dry diets and the earliest a calf will consume sufficient of the latter to make normal growth is usually between 3 and 5 weeks old. For this initial phase of the calf's life therefore a liquid diet is essential.

2. The only nutrients suitable for including in liquid diets for calves under 6 weeks old are those found in cows' milk and glucose. Animal or vegetable fats, such as lard and margarine, can be used in place of butterfat but only if they are first emulsified and homogenized into the diet. Suggested formulae for liquid diets are given in Table 1 (page 27).

3. There is almost no limit to the ingredients of diets suitable for dry feeding. Most concentrate feeds that are given to adult ruminants can be used also for calves, provided they are fed dry.

4. If the transition from liquid to dry feeding is made when the calf is less than 5 weeks old, the concentrate should contain attractive ingredients such as flaked maize and molasses and be supplemented with vitamins A and D. The starch equivalent of the concentrate should be between 65 and 70 and the percentage of crude protein should be between 17 and 20([14]). The concentrate may be pelleted, but for weaning at 3–4 weeks old better results will be obtained if it is fed as a coarse meal. Examples of suitable concentrates for early weaned calves are given in Table 3 (page 28).

5. After 8–12 weeks liquid feeding calves can be weaned on to almost any type of concentrate provided it contains about 16 per cent crude protein. (Most dairy cow production rations are quite suitable for calves weaned at 8 weeks old.) Examples of such rearing concentrates are given in Table 2 (page 27).

CHAPTER II

Management

Management from birth to 3 days old

When cows calve outdoors no attention is necessary at calving unless there is an abnormal presentation. If calving takes place indoors in loose boxes these should be cleaned and disinfected for each cow and well littered. Where it is customary to allow the cow to calve in her stall, more care is necessary and it is important for an attendant to be present. When it is not possible for the calf to be licked by its dam it should be removed to a clean pen and rubbed briskly with straw to dry it and prevent it being chilled. Its nostrils should be cleared of mucous to facilitate breathing. It is a wise precaution to dress the navel of the newly-born calf with an antiseptic such as iodine

or 5 per cent copper sulphate, since this is a common point of entry for disease producing bacteria.

Opinions differ as to the length of time a calf should be left with its dam but, in general, and particularly where whole milk is sold and the calves are reared artificially, it is simpler to remove the calf at birth rather than let it suckle its dam for any length of time. The cow settles more quickly if she is not allowed to become accustomed to the calf and if the latter is to be taught to drink from an open pail this is accomplished much more quickly if it has had no opportunity of sucking its dam.

Importance of colostrum

It is essential that the calf is fed its mother's milk, or colostrum, at least twice during its first 24 hours of life and preferably for a further 48 hours. As stated earlier colostrum contains antibodies which increase the resistance of the calf to the common diseases, particularly white scour. These antibodies can pass unchanged through the wall of the gut into the bloodstream only during the first 24–36 hours of life; thus it is important that the calf be fed as soon after birth as possible. The composition of colostrum changes to that of normal milk within 4 days of calving. Where cows have been milked for more than 4 days before calving, the calves may be deprived of antibodies and thus made susceptible to disease. In such cases calves should if possible be fed colostrum from another cow or, if prepartum milking is regular practice, a supply of colostrum should be stored in a deep freeze cabinet for use when required. When neither of these sources is available, experiments have shown that the best safeguard against infection is provided by feeding 250 mg of chlortetracycline daily for 5 days and then 125 mg daily for a further 16 days.(8)

Teaching the calf to drink

The calf should be backed into a corner of the pen and its head guided into the bucket of milk by allowing it to suck two fingers, spaced slightly apart, which have been previously dipped in the milk. After one or two feeds the fingers should be withdrawn gradually and the calf encouraged to drink unaided. Some calves are very slow to acquire the art of drinking unaided and considerable patience is needed by the rearer.

Level of feeding

It is important not to overfeed the calf during the first 3 days and 6 pints daily should be the maximum allowances for all but the heaviest and strongest calves. While it is preferable to give this daily amount divided amongst three feeds, this is rarely practicable. Twice daily feeding is more common since this fits in with the normal milking routine.

Care of the purchased calf

Calves bought in for rearing should be isolated on arrival at the farm. They are usually hungry, particularly if they have had a long train journey, and if given the opportunity would drink too much milk with consequent digestive upsets. The feed should be 3 pints of warm water. At the next feed the calf can be given the recommended allowance of milk or milk replacement.

Management from 3 days old to 84 days old

Selection of calves

The selection of heifer calves for future milk production should be based on the suitability for this purpose of the calf's dam and particularly her sisters and half sisters where such records are available. Factors to be considered are lactation records with special reference to persistency of yield, butterfat percentage, ease of milking, fertily and longevity. The importance of conformation has been overstressed in the past, but attention should be paid to the shape of the udder and the spacing of the teats as these are important in machine milking. A good dairy cow must also have strong hindquarters and legs.

Choosing a bull calf for breeding is more difficult. If possible he should be sired by a bull himself proven for transmitting good qualities to his offspring. Failing that, a calf should be selected on the basis of the records of his sisters and half sisters. It is a safe recommendation that a calf should never be selected as a future stock bull unless such records are available.

When calves are wanted for beef production, knowledge of their parentage is still valuable although not so essential. Much depends on the degree of quality aimed for in the final carcass. For example, when a high quality carcass is required at an age of no more than 18 months, then the calf should preferably be the offspring of a beef bull out of a dam which itself was sired by a beef bull. It is not enough for such calves to be colour marked, since this indicates the nature of the sire only and the dam could be of pure dairy type. For average quality beef such colour marked calves are quite suitable, although care should be taken to ensure that they are not too fine in the hindquarters as this would indicate that they were out of an extreme dairy-type dam. Finally, and many authorities would rate these calves first as regards profitable beef production, there are steer calves of dual purpose breeds such as the Dairy Shorthorn and the Red Poll, and of the heavier dairy breeds such as the Friesian. Steer calves of the latter breed in particular can be very economical beef producers due to their inherent high rate of growth which tends to offset any limitations in their carcass value.

Within any breed or cross breed, preference should be given for the bigger, stronger calves since size at birth is directly related to subsequent rate of growth. A broad back and wide hindquarters are also good indications of suitable beef type conformation.

Required rate of growth

There is considerable experimental evidence accumulating from many countries, including the United Kingdom, Sweden and the United States of America, that there is no advantage in rearing dairy replacements on a high compared with a moderate plane of nutrition; in fact it is economically wasteful. Workers at the Rowett Research Institute have defined such a moderate plane of nutrition as one which results in an average rate of live-weight gain from birth to 3 months before first calving of 1·0 lb per day for Friesians and 0·9 lb per day for Ayrshires. With this level of feeding the average age of first oestrous is about 16 months with average first calving at 27 months. While this is sufficiently early for most conditions (the average age at first calving of 80 per cent of the heifers in National Milk Records is between 32 and 36 months) certain farmers may require heifers to calve at

24 months or earlier and in such cases higher rates of gain would be necessary. Experimental findings suggest that such accelerated growth should be achieved after the calf is 9 months old rather than during the early, more expensive phase of the rearing period.(1)

Whatever the level of feeding adopted during the rearing period, it is imperative that the heifers are well fed during the last 3 months of pregnancy.

In general beef calves should be fed to gain at as fast a rate as possible provided consideration is given to the cost of achieving that gain. For example, overall rates of liveweight gain during the first 3 months of over $1\frac{3}{4}$ lb per day can generally be obtained only by single suckling or by liberal feeding of milk or milk replacements. These methods of rearing may be justified where the resultant carcass commands a premium, or in an area which qualifies the rearer for considerable subsidies, but for average beef production such methods are generally too expensive. A daily gain of 1·3 to 1·5 lb per day can be produced by artificially rearing at much less cost and from 3 months old, irrespective of how the animal has been reared previously, rate of growth can be fixed at any level of up to 3 lb per day by regulating the degree of concentrate feeding.

The other point is that, when adequate amounts of food are available, an animal previously subjected to low or moderate feeding will compensate for this by very efficient and rapid growth. Thus it may be ecomic to reduce the level of feeding during winter when food is expensive, so that the animal will grow proportionately more during the summer on grass, which is usually cheap.

Level of feeding

Whatever system of rearing is adopted all calves must be fed milk or a liquid milk replacement for the first 3–5 weeks of life. The amount to be fed daily will depend to some extent on the rearing system employed but in general, during the first 3 weeks, it should not exceed 8 per cent of the calf's birth weight in the case of whole milk or $1\frac{1}{4}$ per cent of birth weight for milk replacement powder. This daily allowance should be divided equally between two feeds which usually will coincide with the times of milking.

Temperature of milk

Milk or milk replacements should be fed at or slightly below body temperature, i.e., 100°F. Calves have been known to thrive well when fed cold milk from birth, but it is usually simpler to teach them to drink when the milk is warm. It is important when preparing milk replacements that the final temperature does not exceed 100°F, for it is better to feed liquids too cold than too hot.

Preparation of milk replacements

Milk replacement powder should be reconstituted with 8 times its weight of warm water. It is best not mixed in bulk because the powder does not always remain suspended in water and tends to form a sediment at the bottom of the container. The most satisfactory method is to measure the prescribed quantity of warm water (the average quantity is 3 pints) for each calf into pails, add the milk powder (a measure which holds enough for one

feed can be made from a tin or cup) and mix with a wire egg beater. Do *not* put the powder in first and then the water.

Open pails versus teats

Nipple pails and syphon tubes fitted with teats which are designed to allow the calf to feed by sucking ensure that it drinks more slowly, but there is no experimental evidence that this controls digestive upsets or promotes better growth. Open pails are easier to clean and sterilize and are preferred by most rearers.

All utensils used for preparing and feeding milk or milk replacements should be washed and sterilized after each feed. Galvanized pails should be sterilized in a steam chest but those made of plastic or rubber are most conveniently sterilized by storing them between feedings in a solution of 0·5 per cent caustic soda, similar to that used for immersion cleaning of milking utensils.

Dehorning*

All cattle, with the possible exception of special pedigree animals, should be dehorned before they are 3 weeks old.

Cauterization

Dehorning with a cauterizer is a method commonly used on farms and, although it has not yet been officially recommended by the Ministry, in the author's opinion it is an efficient procedure. But the operation must be preceded by a local anaesthetic administered by, or on the advice of, a veterinary surgeon. A proprietary cauterizer which is heated by an electric element operated either by a 12 volt battery or from the mains supply is most suitable. This instrument can be purchased from most veterinary chemists. A soldering iron of approximately $\frac{3}{8}$ in. diameter can be adapted by shaping the end so that it is slightly concave. It should be heated in a fire or brazier to just below red heat.

The most suitable age to dehorn with a cauterizer is between 2 and 3 weeks when there is a sufficient growth of horn bud to hold the iron in position. It is better to clip the hair from around the horn bud first although this is not essential. The cauterizer should be heated and applied to the horn bud at short intervals until there is a complete ring of cauterized tissue to a depth of $\frac{1}{8}$ in. around the base of the horn.

Caustic potash

Dehorning with caustic potash is not as efficient as with the cauterizer but, provided it is done when the calf is between 2 and 5 days old, it can be made to give good results.

The hair should be clipped from the horn bud and a moistened stick of caustic potash (obtainable from most chemists) rubbed on the centre of the bud for 15 seconds. Petroleum jelly should be applied around the outer rim of the horn bud to prevent the spread of caustic on to the skin. The application

* The Protection of Animals (Anaesthetic) Act, 1954, requires that all operations (with some specified exceptions) on animals must be done under a general or a local anaesthetic, administered so as to prevent any pain during the operation.

should be repeated at intervals of 5 minutes until either a slight indentation has been made in the centre of the horn bud or a slight trace of blood appears. When performing this operation, it is wise to wrap brown paper round the end of the stick to prevent burning one's fingers.

The stick of potash should not be moistened too much or corrosive liquid will spread to the skin adjoining the horn and possibly to the eyes, with harmful results. For the same reason calves should be prevented from getting their heads wet, or sucking nurse cows, until several days after the operation.

Flexible collodion

Flexible collodion is applied in the same way as caustic potash, although it is better to carry out the operation before the calf is 2 days old.

The hair should be clipped from the horn bud and the area wiped with a cloth moistened with methylated spirits or any defatting solvent. After rubbing in a small amount of collodion on the horn bud, a second application should be painted on and allowed to dry. The horn bud should be examined on succeeding days and, if the collodion film is broken, a further application should be given. Unless this method is carried out carefully the calf may suffer for an unduly prolonged period.

Castration

Bull calves for beef production must be castrated before they are 9 months old. Opinions differ as to the optimum time to carry out this operation, but it has been the author's experience that artificially reared calves in particular receive less of a setback if they are castrated at 4–5 months old rather than at 3 months old or earlier. There are three ways of castrating calves but the third method, involving the use of rubber rings, should only be applied to calves that are less than 2 weeks old.

Surgical castration

Castration with a knife is the most efficient method but there is a risk of infection, hence great care is needed to ensure that the site of the operation, the utensils and hands of the operator are disinfected. The operation can be performed quite simply with the calf in a standing position. Two slits are made in the bottom of the scrotum, the testicles are drawn out in turn and the cord of each broken or severed in such a way as to minimize bleeding. Bleeding may be considerable if the cord is cut with a sharp knife but can be prevented by subsequently cauterizing the end of the cord with a hot iron. Alternatively, the cord can be cut with a special instrument (emasculator), resembling a large pair of scissors, which in the act of cutting also crushes the end of the cord. A non-corrosive disinfectant should be applied to the scrotum immediately after the operation.

Burdizzo or bloodless castrator

The bloodless castrator is an instrument, resembling a large pair of pincers, which is designed to crush the cord leading from the testicles up into the body cavity. Crushing the cord prevents the supply of blood to the testicles so that they atrophy within 2–3 months. The technique of using this instrument consists of manoeuvring each cord to the side of the scrotum, applying the jaws of the castrator to this point and crushing the cord by closing the

handles of the castrator. Each cord should be crushed in two places. The operation can be carried out from the rear of the calf while it is in a standing position or the calf can be thrown and restrained on the ground.

Elastrator

A tight rubber ring is put round the scrotum above the testicles by means of a special instrument termed an "elastrator". The pressure of the ring stops the circulation of blood to the lower part of the scrotum, including the testicles, and in due course these tissues wither away completely. Rubber rings should not be used for castration of the calf if it is more than 2 weeks old. There is some evidence that the method involves more sepsis and pain than either of the other two, and it is not advocated.

Removal of Extra Teats

Extra teats on the udders of heifer calves should be removed before the calf is 1 week old. After disinfecting the adjacent area the unwanted teats should be cut off close to the udder with a pair of curved surgical scissors.

CHAPTER III

Feeding

FEEDING TO TWELVE WEEKS OLD

Dairy Calves by Bucket Feeding

There is little justification for the rearing of dairy stock by natural suckling except to make use of cows which are unsuitable for routine machine milking and even then it may be more economical to dispose of such animals. My remarks in this section refer, therefore, to rearing by pail feeding.

Feeding systems can be defined according to the length of time the calves are to be fed liquid diets, namely,

1. extended liquid feeding to 8–12 weeks old; and
2. limited liquid feeding to 3–5 weeks old.

These two main divisions can then be further subdivided depending on whether the liquid diet is cow's milk or a synthetic milk replacement.

Feeding of whole cow's milk to 8–12 weeks old

This method is expensive and under present conditions it is difficult to justify on the efficient dairy farm, but since all methods of rearing are derived from whole milk feeding it will be convenient to describe it first.

Colostrum is fed for the first 3 days and then whole cow's milk at the daily rate of 10 lb for every 100 lb of the calf's birth weight, e.g., the allowance for Friesian calves is approximately 8 pints and for Ayrshires 6 pints. The calf should have access to good quality hay and clean water at 2 weeks old and at 4 weeks should be started on a rearing concentrate. A rearing concentrate should contain approximately 16 per cent crude protein and conform to the following basal formula: 83 per cent cereals, 15 per cent decorticated groundnut meal or soya bean meal, 2 per cent minerals and vitamins A and D. Examples of typical rations are given in Table 2 (page 27). Milk feeding is

continued until the calf is between 8 and 12 weeks old, by which time it will have consumed about 70 gallons, and should then be stopped abruptly. Concentrates should be fed in amounts that the calf will eat up cleanly, up to a maximum of 4 lb daily; this level should be maintained until the calf reaches 12 weeks old.

Feeding of synthetic milk replacement to 8–12 weeks old

At the present time the most suitable alternative to whole cow's milk is fresh skim milk. Unfortunately, except where the cream is separated on the farm it is usually impossible to obtain regular supplies of the fresh skim milk. It is not satisfactory to feed soured milk and, as yet, methods for preserving skim milk with formalin and other germicides are still in the experimental stage. In experiments at the Rowett Research Institute it has been found that buttermilk powder and skim milk powder, when reconstituted with warm water, give satisfactory results. Whey can also be fed to young calves but it should be mixed with twice its weight of either skim milk or buttermilk. Calves reared on reconstituted milk replacements do not grow as fast as those reared on whole milk and there is usually a greater incidence of scouring. Nevertheless growth rates of about 1 lb per day can be obtained when reconstituted buttermilk, skim milk or mixtures of these with whey and/or glucose (see Table 1, page 27) are used to replace cow's milk in the diet of the calf from the age of 3 days onwards. Supplementary vitamins A and D should be added to a milk replacement although this may not be necessary if either good quality hay is fed or the rearing concentrate is supplemented with these vitamins.

The recommended procedure is as follows:

Colostrum is fed for 3 days. On the fourth day the calf should be given milk powder reconstituted with 8 times its weight of warm water at the daily rate of $1\frac{1}{4}$ lb powder for every 100 lb of birth weight. From this stage the procedure is the same as for extended feeding of whole milk.

Instead of milk powder, the rearer has a choice of several proprietary milk replacements, a variety of which are on offer from the leading compounding firms. When such proprietary foods are used, it is essential to follow the manufacturers' instructions regarding the age of animal to which they should be fed.

Early Weaning

The early weaning system of rearing is based on the knowledge that even in the very young calf solid food passes into the rumen where it is fermented and digested mainly by micro-organisms in the same way as in the adult cow. Offering the calf a palatable concentrate encourages it to eat and thus accelerates rumen development, enabling the calf to utilize simple and relatively inexpensive foodstuffs at an early age.

During the course of experiments at the Rowett Research Institute over the past 3 years [11] it has become evident that calves can be weaned quite safely at 3 weeks old provided that at the time they are eating $\frac{1}{2}$ lb of concentrates daily and are not ill or very weak due to a previous illness. It seems necessary to make these provisos, since it has been found in numerous trials involving several hundred animals that the growth rate during the first month is a good indication of the probable growth rate in the next two. When a calf has been very ill, e.g., with scours, during the early weeks and

it has lost weight during this period, its progress after early weaning has often been poor. In farm practice, therefore, such calves should continue to be fed a liquid diet until they are 5 or 6 weeks old before being weaned on to dry food.

A further point, which has been demonstrated in experiments at the National Institute for Research in Dairying[19], is that the incidence of infectious scour in the calf house increases with successive occupancies. Thus, where larger numbers of calves are reared, the incidence of infectious scour can be expected to be high and under these conditions the age of weaning should be delayed to 4–5 weeks old. On the other hand, when rearing is less intensive or is seasonal, i.e., the calf house is left empty for several months between successive occupancies, there should be a negligible scour problem and weaning can take place safely as soon as the calves are 3 weeks old.

Weaning from whole milk between 3 and 5 weeks old

The following method has proved satisfactory on a large number of farms.

After 3 days on colostrum the calf is fed whole cow's milk at the daily rate of 8 lb of milk for every 100 lb of birth weight. This rate of feeding is equivalent to 5 pints daily for calves weighing 70 lb (e.g., Ayrshires) and 6 pints daily for 90 lb calves, such as Friesians and Shorthorns. At this stage the calf is offered clean water and good hay. In the early stages at least, drinking water should be provided from pails rather than from water bowls and should be changed daily. Consumption of meal is dependent on the calf drinking water and in very cold weather this can be encouraged by giving warm water for the first 7–14 days after weaning, although there is no need to continue the practice beyond this stage. From the age of 10 days the calf is given $\frac{1}{2}$–$\frac{3}{4}$ lb of concentrate daily, the mixture being of the type recommended for early weaning (see Table 3, page 28). Fresh quantities are given every day, any uneaten residues being fed to older stock. Milk feeding is continued until the calf is between 3 and 5 weeks old and then stopped abruptly. Strong, healthy calves can be weaned safely at 3 weeks provided that they are eating $\frac{1}{2}$ lb meal daily. On the other hand, small weak calves and particularly any that have been ill with scours are best fed milk until they are at least 4 or 5 weeks old.

It has been found that there is no advantage to be gained from weaning the calf gradually and abrupt weaning is much simpler to carry out in practice[12, 18]. On the day after the calf has had its last feed of milk, its concentrate allowance is increased to $1\frac{1}{2}$ lb daily and thereafter the calf is fed to appetite until it is eating 4 lb daily. Most early weaned calves will be eating this quantity by the time they are 8 weeks old.

When the calf is 12 weeks old the early weaning concentrate is replaced by a simple rearing mixture (Table 2, page 27). This change over to the new diet is best made gradually over a period of about 1 week.

Early weaning from synthetic milk replacements

This method is designed mainly for the rearer who purchases calves and does not keep cows. It can also be used on the dairy farm where the aim is to sell every possible gallon of whole milk.

The only difference from the technique outlined previously for early weaning is that liquid cow's milk is replaced with a reconstituted milk replacement either from the time the calf is 3 days old, as in the case of those

Weaned at 3 weeks

Conventionally reared, weaned at 12 weeks

FIVE-MONTH-OLD IDENTICAL TWIN AYRSHIRE CALVES

Weaned at 3 weeks

Weaned at 12 weeks

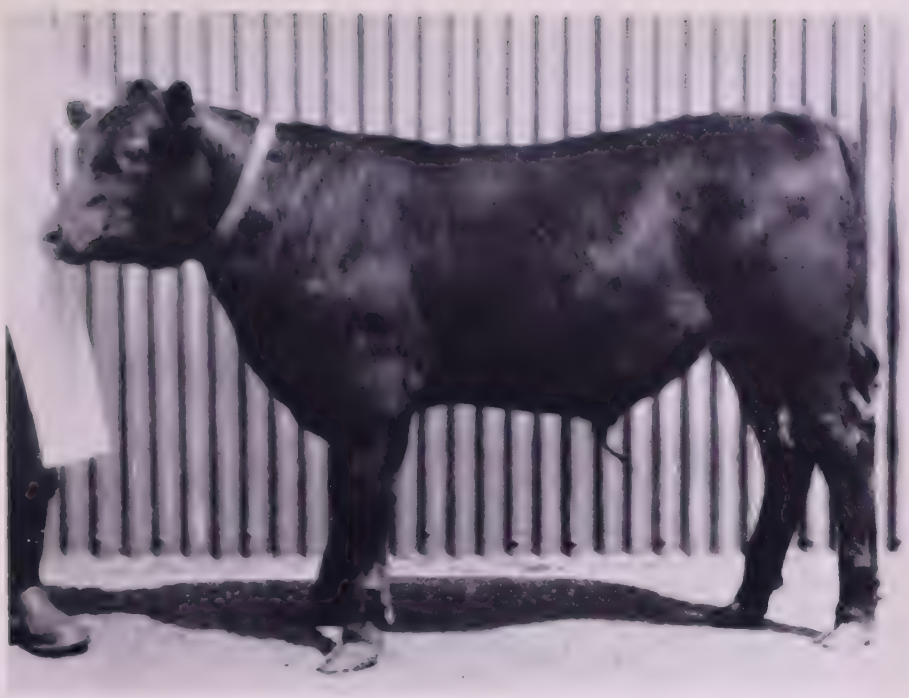
AYRSHIRE HEIFERS

IDENTICAL TWIN AYRSHIRE HEIFERS

Left: weaned at 3 weeks
Right: weaned at 12 weeks

AYRSHIRE HEIFERS

Left: weaned at 3 weeks
Right: weaned at 12 weeks

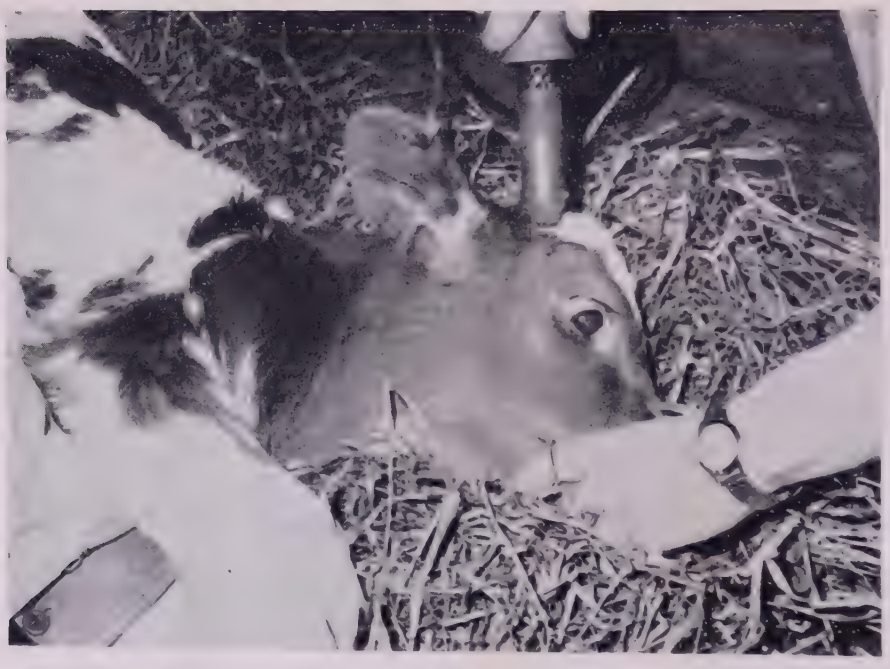


NINE-MONTH-OLD ABERDEEN-ANGUS × SHORTHORN STEER
(live weight = 530 lb) weaned at 3 weeks

EIGHTEEN-MONTH-OLD FRIESIAN STEER (live weight = 1,176 lb)
weaned at 3 weeks

PLATE III

CASTRATION WITH BURDIZZO BLOODLESS CASTRATOR



DEHORNING WITH ELECTRIC IRON

bred on the farm, or from the time of arrival on the farm, in the case of purchased calves.

The rate of feeding should be 1¼ lb milk powder per 100 lb birth weight. This is equivalent to 1 lb milk powder daily for average Ayrshire calves and 1¼ lb daily for Friesian calves.

Since calves do not grow as fast on milk replacements as on whole milk and as there is usually a greater incidence of scouring, it is safer to delay weaning until the calf is 4 weeks old. Purchased calves always suffer quite a severe setback in transit and they should be kept at least 3 weeks on liquid feeding before weaning, irrespective of their age at purchase.

Calves for Beef Production

Single suckling

Suckling is the traditional method for rearing pedigree beef cattle; it is the only practicable method of rearing commercial cattle on hill or marginal land. Mortality amongst beef calves suckled by their dams is low and generally the technique is fairly free of trouble except where the diet of the in-calf animal is of poor quality. Muscular dystrophy, caused by a deficiency of Vitamin E, has been reported in suckling beef calves in parts of the north-east of Scotland [2] but the trouble is not widespread*. Suckled calves kept indoors without access to concentrates or roughage may suffer from anaemia due to iron deficiency[3], but again this condition is rare since it can be easily prevented by providing the calf with supplementary foods which always contain adequate amounts of iron.

Double suckling is occasionally practised on beef rearing farms, a purchased calf being put on to a recently calved cow and reared, at grass, alongside the cow's own calf. Though in some respects economical, the system is beset by many practical difficulties and is not widely practised. It may result in two indifferent calves which leave less profit than the one good calf the dam would have reared if left only with her own.

Multiple suckling

Multiple suckling, i.e., the rearing of three of more calves on a cow which is usually of the heavier milking dairy breeds, is practised on many lowland farms. At one time the system was considered to be the most efficient one for rearing calves for beef production, although with recent improvements in methods for rearing calves artificially this claim is less valid today.

The advantages claimed for multiple suckling are that it is economical in labour and calves so reared grow rapidly in the early stages. There is some doubt, however, as to whether these points outweigh the disadvantages of the method which are:

1. the mere fact of having to keep cows;
2. a high incidence of scour amongst the calves due to the impossibility of controlling their intake of milk;

* The typical winter rations there of oat straw and swedes are low in Vitamin E, consequently the colostrum and milk—the main sources of vitamins for the young calf—contain insufficient amounts of this vitamin. The condition can be prevented by feeding to the cow conserved greenstuff such as silage or dried grass which supplies adequate amounts of Vitamin E.

3. difficulty in inducing cows to adopt calves other than their own;
4. inflexibility of the system in that calves must be purchased in accordance with the calving date and milk yield of the cow; and
5. the difficulty of detecting oestrous on farms where no bull is kept.

The number of calves that can be reared on each nurse cow depends on the yield of the cow and the length of time the calves are allowed to suckle. The aim should be to supply each calf with 1 gallon of milk daily. Until quite recently, the normal practice has been to continue suckling for 10–14 weeks, hay and a rearing concentrate being fed from 4 weeks onwards. Each calf would thus consume between 80 and 100 gallons of milk.

Nowadays multiple suckling is often combined with early weaning. Hay and an early weaning concentrate are offered at 3 weeks, and at 5–6 weeks suckling is abruptly stopped. At 10–12 weeks a rearing concentrate is substituted for the early weaning concentrate in the manner already described.

Calves bought in for multiple suckling should be between 1 and 2 weeks old, since at this age they are less liable to suffer digestive upsets when first put on to the nurse cow. To induce the cow to adopt calves it is often better to remove her own calf, which might otherwise receive favoured treatment, and present her with a group of fresh ones. The cow should be fed before the calves are let in to suckle but, if she is still unduly restive, she should be restrained by any of the usual measures. If possible the calves should be tied up for a short period following suckling, at least until they are 1 month old, since this will help to prevent them from sucking each other. It is sometimes better to allow the first batch of calves to suckle the cow thrice daily during the first week, but subsequently twice daily suckling is adequate.

Multiple suckling is sometimes practised in dairy herds with nurse cows which have become dry in one quarter due to mastitis, or which are slow milkers. But very often a cow that is inefficient for milk production is likely to be equally inefficient for multiple suckling and is probably better culled immediately.

Artificial rearing

One of the most marked trends in beef production in the last 2 years has been the development of the practice of rearing on farms which have no cows at all. This change has been made possible by our increasing knowledge of the nutritional requirements of the young calf and has been accelerated by the need to increase the efficiency of what has been, in the past, one of the least intensive of our farming enterprises.

The method has grown up with the trade in cross bred calves from dairy herds. Suitable calves are those from the heavier dairy breeds or first crosses from these by beef bulls. Such calves are fed colostrum on the farm where they are born and sold to the rearer when they are between 1 and 2 weeks old.

As no cows are needed there is no limit, other than labour and accommodation, to the number of calves that can be reared at any one time. Calves can be bought in groups of any size exactly when the rearer wishes and this simplifies management.

The methods of rearing are almost identical with those outlined on pages 13 and 14 for dairy calves, the only difference being that the level of concentrate feeding is increased to 5 or 6 lb daily in the third month of life instead of the 4 lb recommended for dairy heifers.

Rearing calves for veal

The practice of feeding calves on whole milk for veal has declined markedly in recent years since this traditional method of feeding is quite uneconomic when such milk can be sold for human consumption.

The increasing availability of liquid skim milk promises to make veal production more profitable, although the urgent need at the moment is for a preservative which will enable the skim milk to be kept to allow for deliveries from the creamery once or twice per week.

One-and-a-half gallons of skim milk should produce a liveweight increase of 1 lb, or approximately ½ lb of veal. If veal can be sold at 3*s.* per 1 lb and skim milk can be bought for less than 6*d.* per gallon, this system could prove quite profitable but obviously much depends on the value of the calf on the store market.

One method of using fresh skim milk for veal calves is as follows:

After 3 days colostrum for home bred calves, or on arrival in the case of purchased animals, each calf should be fed 3 pints of skim milk at each of two feeds. After 1 week at this restricted level, skim milk should be fed to appetite so that by the time the calf is ready for slaughter, at about 12 weeks old, it is consuming from 4–5 gallons daily. To get the calf to drink these large amounts no water must be given. Neither hay nor concentrates should be fed to veal calves since it is claimed that these lower the quality of the carcass. If, for some reason, supplies of fresh skim milk are not available, dried skim milk reconstituted with 8 times its weight of warm water can be fed instead. In either case stabilized vitamins A and D and minerals should be added at the recommended rates (see Table 1, page 27).

In general, veal from calves fed with liquid skim milk or any milk replacement, based solely on dried milk by-products, is of poorer quality than veal from calves fed liberally on cow's milk. The chief reason for this is that the energy content of most milk replacements is low since they contain little or no fat. The problem of incorporating supplementary vegetable or animal fats in milk replacements without excessively increasing their cost is now under investigation in the United Kingdom. One or two manufacturers are, in fact, marketing fat-supplemented milk replacements which are designed specially for veal production and similar products are being imported. Overall growth rates to 12 weeks old on these high energy milk replacements are much more rapid than with standard milk replacements and may be as high as 2½ lb per day.

Profitability of veal production on this system depends on the cost of the calf, the sale price of the product, the killing out percentage and the food conversion rate. Of these factors, food conversion rate is the one most affected by management. Specialist housing, which ensures that the calf is free from draughts and is at a *constant* high temperature (65–70°F), and the minimum of disturbance are essential if very high conversion rates are to be obtained. Absence of sunlight, although not necessarily complete darkness, is also desirable.

The reconstitution of high fat milk replacements requires special precautions. The dilution rate should be 8 parts of water (by weight) to 1 part of milk powder as is recommended for all standard replacements. But for really efficient mixing it may be necessary to first mix the powder with cold water to form a paste, then add boiling water which will break up the fat and finally cold water to bring down the final temperature to 100°F.

Value of Grazing for the Young Calf

It is a traditional belief amongst British farmers that young calves should not be turned out to graze until they are at least 6 months old. The main reason for this is the fear that such calves will become infected with husk. Fortunately, promising drugs are now on the market[22] and there is a vaccine which is designed to provide immunity against husk infection[9].

It was also thought that the very young calf could not utilize fresh grass, but recent research has shown that, in fact, at 3 weeks old the calf can digest fresh grass as efficiently as the adult cow[15]. Provided, therefore, that the calf is able to consume sufficient herbage to maintain adequate growth, it should be possible to rear it on pasture from quite an early age.

New Zealand experience[11] and the results of limited studies in this country[13, 21] have indicated that given a fairly mild climate, good pasture and opportunity to graze extensively, and hence selectively, calves can be weaned at 8 weeks old from milk direct on to pasture without any supplementary feeding of concentrates. If any of these conditions cannot be ensured, calves can still be reared outside, but it will be necessary to feed them 2–3 lb of concentrates per head daily. Since it is not always convenient to feed milk or liquid milk replacements to calves outside, the best method would be to rear them indoors by one of the systems outlined previously and turn them out on pasture approximately 2 weeks after weaning[16]. Concentrate feeding should be continued outside at the rate of 3–4 lb per head per day until the calves are 12 weeks old. At this stage, if the pasture is of good quality, supplementary feeding could be stopped and the calves thereafter reared on pasture alone. Subsequent management should aim at moving the calves round different pastures, preferably ahead of the dairy cows. But, if the weather should turn wet and cold or if the pasturage is of only moderate quality, concentrate feeding should continue throughout the summer and autumn until the calves are housed for the winter. This is in any case a wise precaution where there are risks of husk.

FEEDING AND MANAGEMENT FROM THREE MONTHS TO ONE YEAR

Dairy Herd Replacements

During the period from 3–12 months of age heifers of the heavier breeds, e.g., Shorthorns and Friesians, should gain in weight at the rate of 1 lb per day, whilst lighter breeds, e.g., Ayrshires, should put on about 0·9 lb per day. At no stage should such heifers be fed to put on fat; on pasture during the summer they often do so whether or not the rearer wishes it.

Indoor feeding

From 3–6 months heifer calves should be fed approximately 3 lb per day of a rearing concentrate together with good quality roughage *ad lib*. If the roughage is poor, the level of concentrate feeding may need to be increased to 4 lb per head in order to produce a daily liveweight increase of 1 lb. From 6–12 months the quality of roughage available will determine the amount and type of concentrate that should be fed. If the roughage is of good quality, e.g., hay, dried grass or silage, each well made from leafy herbage, it will suffice to feed 2 lb per head daily of a concentrate mixture containing 10–12

per cent crude protein. When only poor quality roughage is available, it will be necessary to feed 3–4 lb of a concentrate mixture containing 12–14 per cent crude protein.

Outdoor feeding

In general, cattle between 3 and 12 months old will obtain sufficient nutrients from pasture, provided that it is young and leafy, without the need for any supplementary feeding. On poor grass, however, cattle under 6 months old should be fed 2 lb per head daily of a cereal mixture. They should be brought in for indoor feeding fairly early in the autumn before the nutritive value of grass falls too low. This will help to prevent possible husk infection. Supplementary feeding is not necessary for cattle over 6 months old, except in times of severe drought. They can be kept outside as long as there is grass for them.

Beef Cattle

Between the ages of 3 and 12 months beef cattle, generally, should gain in weight at about 1½ lb per head daily. To achieve this the type of rations for indoor feeding should be similar to those recommended for dairy cattle, but the level of concentrate feeding should be of the order of 5–6 lb for artificially reared calves under 6 months old and 3–4 lb daily for older stock.

During the summer, beef cattle under 6 months old should receive up to 2 lb per head daily of cereals. This supplement will not be necessary for older beef cattle, but these should always be grazed on good pastures.

CHAPTER IV

Housing for the Young Calf

Housing for the young calf is determined to some extent by the system by which it is to be reared. In general, when the level of feeding is high, housing is of only minor consideration but, when economies in rearing are sought through restricting the amount of food allowed, housing plays a significant part in controlling the progress of the animal.

The single suckled calf enjoys a very high plane of feeding and such calves may be born and reared under quite adverse climatic conditions.

Multiple suckling is also fairly high plane rearing and requires no special buildings. Isolation of calves suckling different cows is necessary to prevent spread of infection, otherwise major consideration should be given to ease of cleaning and feeding. Loose boxes, each holding three or four calves, are most suitable.

In general, pail fed calves require a much better environment than those which are suckled and calves which are reared on synthetic diets are more exacting in their demands on housing than calves fed on liberal quantities of whole milk.

An environment can be defined roughly in terms of temperature and relative humidity. The optimum values of these for the calf are not known, but in the early stages at least a minimum air temperature of 50 F should

be the aim. Relative humidity is less important than temperature but, if possible, it should not exceed 80 per cent and the air changes to ensure this should be achieved without causing draughts. As the calf grows and begins to consume increasing quantities of food it can probably tolerate lower temperatures without much reduction in growth rate.

Where only small numbers of calves are reared, it is simplest to utilize existing buildings. Laying wooden slats across one corner of a pen and covering them with straw to form a kennel, or providing supplementary heat with infra-red lamps, are simple ways of securing warmth in what otherwise might be cold and draughty buildings.

On the large dairy or beef rearing farm it is best to provide a specialized calf house.

Siting and General Construction

The site should be sheltered with a southern exposure and the house should have as few outside walls as possible. It is best if the entrance door opens off another building, while an additional exit door opening directly outside for cleaning out is an advantage if the unit is large. Space must be allocated for feed bins, buckets, a water point, washing-up trough and a storage heater. This food preparation and storage room should be separate from the calf pens.

The calf house should be of insulated construction. Thick stone walls, as in an old stable, are best but, if a new building is planned, breeze blocks rendered with concrete both outside and inside should be used. The roof should be lined or if it is high, a false ceiling should be fitted at a height of 7–8 ft. Flat asbestos board covered with a layer of glass wool is ideal, although there are alternative materials.

The type of flooring to be laid is determined by certain management factors. Built-up litter is a good floor insulator due to the heat produced from the rotting dung under the clean bedding, but urine is also evaporated by the heat and the relative humidity in such a house may be high. Such a system is more economical of litter than when cleaning out is done weekly, but when built-up litter is removed completely there is a radical change in the environment, due to removal of the source of heat, and if young calves are exposed to such a change they may receive a severe setback. It is of some importance that in a survey of housing practice in Missouri, U.S.A., mortality was 9·1 per cent for built-up litter compared with only 5·5 per cent where regular cleaning was practised.(7) A compromise from the cost angle is to clean out young calves frequently but to allow litter to build up in the unit holding older calves. Maximum comfort for the calf is probably obtained by the use of false floors made from 2 in. by 1¼ in. wooden slats set 1¼ in. apart; these should be well bedded with straw. When such slats are used, the underlying floor can be of concrete. If, however, the calves are to be bedded directly on the floor this must be insulated. In this case a suitable construction would be surface concrete, ⅛ in. bitumen damp-proof course, 4 in. insulated concrete or hollow tiles, ⅛ in. bitumen damp-proof course and 1½ in. cement sand screed. In pens for calves over 6 weeks old where litter is built-up insulated floor construction is not so imperative.

Windows should not be too large, since these would give rise to undue temperature fluctuation; in the colder parts of Britain they should be preferably double glazed.

Baffled air inlets set in the doors ensure freedom from draughts. Extraction should be by an insulated box-like shaft and, although satisfactory results can be obtained with natural ventilation, a fan ensures a positive airflow at all times. For natural ventilation the cross-sectional area of the extract shaft and of the inlets should be 6 sq. in. per 100 lb calf live weight. Fan requirements for power ventilation should be calculated on the basis of 10 cu. ft of air per min per 100 lb calf.

Internal Layout

On the larger farm ideal calf-rearing accommodation should be made up of two separate units, a nursing house and a rearing house. Calves under 7–8 weeks old should be kept in the nursing house—a well-insulated building, fitted with a controlled ventilation system and having provision for heating in winter. After 7–8 weeks and until they reach 16 weeks, they should be reared in the second half of the unit. This house need not have such a controlled environment as the nursing house, but the roof should be insulated and under most conditions power ventilation, but no heat, will be required. In the nursing house the calves should be kept 1, 2 or 3 to a pen, but in the rearing house the pens can be larger, holding up to 6 calves each; automatic water bowls should be installed and feeding arrangements do not need to be so elaborate as those in the nursing house. The advantages of the double-unit plan are as follows:

1. the expense of heating and efficient insulation is concentrated on the animals most in need of a good environment;

2. young calves expire less carbon dioxide and excrete less moisture than older calves, therefore less frequent air changes are necessary in a unit for young calves, and this helps to reduce heating costs;

3. milk feeding, at least for early-weaned calves, is restricted to one building; and

4. infectious disease, which is most likely to affect the calf during the first 5 weeks of life, is also mainly contained within the one unit and can be kept in check by efficient sterilizing.

The design of the pens should be flexible so that the building could have other uses. Pen partitions and fittings should be demountable so that the size of the pens can be altered if required.

Beef calves, which are usually purchased at 1–2 weeks old, should be bought in large groups, preferably within the space of 1 week, so as to fill the nursing house. They should be kept in this house for a period of 6–8 weeks by which time they should be weaned on to concentrates and hay. The whole batch of calves should then be moved to the rearing unit for a further period of 7–8 weeks. At the end of this time the calves will be 16 weeks old and can be transferred to courts and yards. Once the nursing house is empty, the building should be cleaned and sterilized (see later section on hygiene) and then left empty for 2–3 weeks before the next batch of calves is brought in. It is not necessary to sterilize the rearing house between successive batches of calves.

Size of Pens

On a dairy farm where calves are born at intervals, some individual pens are essential, but the remainder should be able to accommodate groups of three of four. As a rough guide, one individual pen and one group pen are needed for every 12 cows in a herd rearing only heifer replacements. Where beef calves are being reared in fairly large numbers they should be kept in single pens, or in groups of 2 or 3, until they are 6 weeks old and, thereafter, groups of 6 to 8 until they are 16 weeks old. The dimensions of calf pens can be so variable that most buildings can be adapted to give an efficient layout of pens; but when constructing a new unit the central passage plan is most economical of space. If possible the feed store should be placed so that it serves as a baffle porch to the nursing unit. This will help to minimize the effect of adverse weather on the internal environment. In all except very small units, an additional exit door opening directly outside for cleaning out is essential. The rearing house should have tractor-width doors so that, when the portable divisions are removed, the whole house can be mucked out by tractor fore-loader. Central passages need be only 3 ft 6 in. wide in small units, but in larger units 4 ft 6 in. to 5 ft is preferable.

The most commonly quoted dimensions for single pens for calves are 5 ft by 4 ft, but this size is only necessary if the calf is to be kept singly to 3 months old. If the double unit plan is used, then single pens in the nursing house for calves less than 6 weeks need be no larger than 4 ft by 2 ft 6 in. Where groups of 3 young calves are being kept together, 8 ft by 5 ft pens are satisfactory; a pen to hold 6 calves between the ages of 6 and 16 weeks should be about 15 ft by 8 ft. For young calves pen divisions 3 ft 6 in. or 4 ft high will suffice but older calves need 4 ft 6 in. high divisions, particularly when litter is built-up.

Most authorities recommend either smoothly rendered cement walls or open tubular steel rails as pen divisions. It is claimed, albeit without any evidence, that the former are hygienic and prevent draughts, while the latter permit ample circulation of air and that the calves benefit from seeing each other. It is rather doubtful whether either of these two types of partition offers the calf any real comfort—and that ought to be the prime reason for constructing a calf house. Concrete walls are cold, encourage condensation and act as cooling panels dispersing the heat radiated from the calf's body. Their so-called advantages of hygiene are realized only if they are scrubbed and disinfected between successive occupations. But even if this practice is adhered to, it still does not prevent build-up of infection. Work at the National Institute for Research in Dairying, Reading[19], and at the Rowett Research Institute[14] has shown that, even with such precautions, there may be a gradual build-up of infection in a calf house which can be remedied only by leaving the house empty for several months. A further criticism of concrete divisions is that they are not easily moved.

Open rail divisions have been described by one veterinary surgeon as death traps. In all but the very best houses such divisions encourage draughts and the spread of infections and allow inter-pen sucking.

In the author's opinion, solid wood partitions are in many ways more satisfactory than either concrete or tubular steel, since they provide greater comfort for the calf. They are easily removed, which facilitates cleaning and disinfection, and they can be exposed to the sun. Choice of suitable fittings,

such as movable divisions, ensures flexibility so that pen sizes can be altered and the whole internal structure dismantled either for cleaning or to house other stock or materials. Pen fronts should be constructed in the form of gates either of tubular steel or of timber with suitable openings and fittings so that the calf can drink from a pail outside the pen. In group pens for young calves it is most convenient if such openings are fitted with yokes so that calves can be secured individually during, and for a short period following, feeding. Food troughs should be removable and secured to the pen front by means of metal hooks. Hay racks should be designed to straddle the partitions. Water bowls that are controlled by a ballcock within the unit are more suitable for calves than the kind which has to be operated by pressure from the animal's muzzle.

Where an early weaning and dry feeding system of rearing is intended, attention to certain details will help to ensure good results. Success with such a system depends mainly on two factors:

1. accustoming the calf to eat meal; and
2. providing it with a favourable environment during the liquid feeding and immediate post weaning stage when its consumption of food is often low.

Encouraging it to eat entails putting meal and water in close proximity to the calf and therefore inside the pen. In the early stages fresh water should be given every day in buckets, not water bowls which are easily fouled and often difficult to clean. This is very important for successful dry feeding.

Hygiene

Each pen should be cleaned and disinfected immediately the calves are taken out. The walls, floor and fittings should be soaked with water and the dung scraped off. The pen should then be scrubbed with a strong solution (4 per cent) of washing soda, or caustic soda, in hot water, and a disinfectant sprayed over all the surfaces. Complete cleaning and disinfecting of the whole building should be carried out once per year preferably in warm weather during the early summer. In specialized rearing units the nursing house holding the young calves should be sterilized after each batch of calves. An effective way of sterilizing the building is with formaldehyde. For every 300 cu. ft of air space use 3 oz formalin and 2 oz potassium permanganate. Block all outlets from the buildings, put the formalin in a large pail, add the potassium permanganate and leave the building immediately! Keep the house closed for 48 hours and then leave empty with opportunity for fresh air to circulate for at least two further days.

CHAPTER V

Calf Disorders

Only the common ailments and difficulties encountered in calf rearing are discussed in this chapter. For a more comprehensive review of diseases associated with calfhood readers are referred to the Ministry of Agriculture's Bulletin No. 169: *Diseases of Cattle**.

White Scour

White scour is a common cause of mortality in young calves. In acute cases, calves die before they are 3 days old from septicaemia caused usually by a strain of *Bacterium coli*. The most important prevention is to ensure that the calf receives colostrum from its dam before it is 24 hours old. Less severe attacks may be associated with a localized intestinal infection of *B. coli* and are characterized by elevation of body temperature and diarrhoea; the calf loses its appetite, it becomes dehydrated and in particular its eyes take on a very shrunken appearance. In many cases the calf dies of pneumonia or other secondary infections, usually before it is 3 weeks old. Such infectious scour is particularly prevalent where large numbers of purchased calves are reared, and it usually starts from 5–10 days after the calf is brought into the calf house. A rise in body temperature to over 102·8°F may be a sign of impending scour. Veterinary advice should be sought immediately if infectious scour is suspected, since a cure might be effected by the use of modern drugs. Strict attention to hygiene will help to limit outbreaks of this disease. Calves introduced from outside sources should preferably be isolated for 2 weeks after arrival; and pens which have been occupied by scouring calves should be cleaned and disinfected before being used again.

Many authorities recommend that the milk allowance should be restricted when scouring is observed, but in the author's experience this often accelerates dehydration and by reducing the calf's resistance makes it more susceptible to infection. In our experiments we have found it better not to reduce the milk or milk replacement allowance for scouring calves below that recommended on page 9, namely, 8 per cent of live weight for milk and $1\frac{1}{4}$ per cent for milk replacement powder.

Nutritional Scour

Nutritional scour, which is also characterized by persistent diarrhoea, is different from the infectious disease, white scour, in that it is caused initially by a digestive upset due usually to over feeding or the use of a poorly digestible milk replacement. The mode in which the condition occurs has been described by Blaxter and Wood.(4) According to these authors the cause of nutritional scour is some form of indigestion in the first part of the alimentary tract, with the results that undigested food passes down into the bowel. Bacteria normally resident in this organ multiply rapidly due to this ingress of undigested material. The food is fermented and broken down into small particles

* Obtainable from H.M. Stationery Office or through any bookseller, price 5*s*. 6*d*., by post 5*s*. 11*d*.

so that the osmotic pressure inside the gut increases, water flows into the gut from the surrounding tissues and the watery mass of partly fermented food and faeces is expelled. If pathogenic bacteria are present in the bowel, then the increase in their numbers consequent upon the arrival of undigested food can lead easily to an infection usually of white scour.

Prevention of nutritional scour thus involves avoiding the primary indigestion. The main cause of indigestion is overfeeding either with milk or synthetic milk replacements, hence it is important to use only good quality milk replacements and not to feed more than the recommended amounts (see page 9) especially during the first 3 weeks of life.

Parasitic Bronchitis or Husk

Calves and young cattle reared on pastures are particularly susceptible to husk, the incidence of which is greatest in late summer and autumn. The symptoms are a discharge from the nose, increased rate of respiration, prolonged coughing and often diarrhoea.

The larvae of this worm are ingested from pasture, pass down into the intestine and then migrate to the lung by way of the lymphatic system and the blood. There the larvae mature into adult worms and after 5–6 weeks lay eggs which in turn hatch into larvae. The larvae are coughed up by the animal, swallowed and thence passed out on to the pasture in the faeces; they become infective to other animals after a period of 5–6 days.

The larvae have little resistance to cold and dryness and pastures which have been free from cattle over winter are usually non-infective. In warm, damp areas the larvae can survive much longer, particularly if the herbage is long, and ploughing up may be the only way to dispose of them completely. Cattle that are well fed are less susceptible than poorly fed ones and where the risk of infection is great young stock on pasture should be fed additional concentrates. New drugs for treatment of the condition are now on the market and there is also a vaccine which is designed to give immunity to husk infection. For effective immunization the vaccine must be given in two doses at an interval of 4 weeks, the last dose being administered at least 2 weeks before the calves are put out to grass.

If young cattle on pasture show symptoms of husk, they should be housed immediately, fed a good ration and put on a course of treatment prescribed by a veterinary surgeon.

Parasitic Gastritis

All grazing animals, and even housed ones, are infected to some extent by small round worms. Provided calves are well fed little harm results from such parasitism. It is only when the animal's resistance is reduced, due to inadequate nutrition or climatic stress, and it is exposed to a severe worm infestation, that its health is affected.

The symptoms of parasitic gastritis are a steady loss of condition, increasing unthriftiness and, in severe cases, diarrhoea; affected animals often appear anaemic.

Eggs laid by the adult worm pass out in the faeces on to the pasture and there hatch into larvae which become infective to other animals within 5 days. Larval development on the pasture is favoured by warm humid conditions and overstocking. Incidence of the disease is greater at the end of

the grazing season when pastures are heavily infected and their nutritive value is beginning to deteriorate.

Prophylaxis should aim at keeping grazing cattle on a rising level of nutrition and avoiding overstocking; routine dosing with anthelmintics during the grazing season may reduce the number of worms in the calves and the number of worm eggs which reach the pasture.

Bloat

Bloat in young calves may be caused by milk replacements (particularly if they have a high content of soluble carbohydrates) getting into the infantile rumen and being fermented by the bacteria there. In such cases the milk replacement allowance should be reduced and the calf weaned on to dry food as soon as possible. Early weaned calves are also susceptible to bloat, usually at about the 5–10 week old stage. In some cases, it is because they are being under-fed with concentrates. Consequently when they are fed they eat much too quickly and the rapid fermentation of this food causes bloat. This condition can be cured by giving food in excess of requirements, which encourages the calf to eat less rapidly and at more frequent intervals. If a calf continues to bloat despite the above treatment, it may be because the lining of the rumen is damaged or ulcerated. In one or two instances a cure has been effected by depriving the calf of concentrates and hay for 10–14 days and during this time feeding only small quantities of milk and a poor quality roughage such as straw. Once the calf has shown no signs of bloating for at least 10 days concentrates can be gradually reintroduced.

Appendix

TABLE 1

MILK REPLACEMENTS SUITABLE FOR FEEDING TO CALVES WHICH HAVE BEEN GIVEN COLOSTRUM

Ingredient (*lb*)	(*a*)	(*b*)*
Roller-dried skim milk‡	60	60
Spray-dried buttermilk or spray-dried skim milk‡	30	25
Glucose	10	—
Margarine, lard or tallow	—	15
Supplements		
Vitamin A (i.u.)	200,000	
Vitamin D (i.u.)	44,000	
Minerals (lb)†	1·5	

* This diet must be homogenized before being fed in order to reduce the fat globules to a size the calf can utilize, namely, 2 lb.

† The mineral supplement should contain the equivalent of 93·5 per cent magnesium carbonate, 3 per cent copper sulphate, 3 per cent manganese sulphate and 0·5 per cent cobalt chloride. This supplement is only necessary if the milk replacement is the sole diet, e.g., as for veal calves.

‡ Spray-dried milks are subjected to lower temperatures during drying than roller-dried milks and so they have a slightly higher nutritive value. On the other hand, experience indicates that a mixture of roller-dried and spray-dried milk causes less scouring than when only spray-dried milk is used.[14]

TABLE 2

REARING CONCENTRATES FOR CALVES WEANED BETWEEN 8 AND 12 WEEKS OLD AND FOR ALL CALVES BETWEEN 3 AND 6 MONTHS OLD

Ingredient (*lb*)	(*a*)	(*b*)	(*c*)
Maize meal Bruised barley Bruised oats *	476	420	448
Decorticated groundnut meal or soya bean meal	84	—	56
Linseed cake meal	—	140	56
Supplements			
Ground limestone (lb)	3		
Sterilized bone meal (lb)	3		
Salt (lb)	3		
Vitamin A (i.u.)	1,000,000		
Vitamin D (i.u.)	200,000		

* In general, choice of any one or combination of these cereals should be governed by their relative cost per unit of starch equivalent but for calves under 3 months old the palatability of the ration will be improved by including 30 per cent of either flaked maize or maize meal.

TABLE 3

EXAMPLES OF EARLY WEANING CONCENTRATES FOR CALVES WEANED BETWEEN 3 AND 5 WEEKS OLD

Ingredient (lb)	(*a*)*	(*b*)*	(*c*)*
Flaked maize	224	224	196
Bruised oats	168	140	84
Molassine meal	84	84	56
Soya bean meal	28	28	56
Fish meal	56	56	—
Screened linseed	—	—	56
Dried skim milk	—	—	56
Cane sugar	—	—	28
Kibbled locust beans	—	—	28
Tallow†	—	28	—
Supplements			
Salt (lb)	3	3	3
Vitamin A (i.u.)‡	1,000,000	1,000,000	1,000,000
Vitamin D (i.u.)‡	200,000	200,000	200,000
Aureomycin or Terramycin (grams)§	4·5	4·5	—

* Mixtures (*a*) and (b) incorporate the most recent developments in the formulation of early weaning diets as recommended by the Rowett Research Institute. Mixture (b) is not very suitable for farm mixing unless the tallow can be obtained as a premix with the fish meal and soya bean meal. Mixture (c) was developed by the School of Agriculture, King's College, Newcastle-on-Tyne.

† The tallow should contain an anti-oxidant and should have a free fatty acid content of less than 1 per cent.

‡ Vitamins A and D should be supplied in dry stabilized form since feeding cod liver oil to calves may cause muscular dystrophy.

§ Aureomycin and terramycin can be obtained in various forms. For convenience of incorporation in the above type of ration, aureomycin and terramycin are available as Aurofac 2A (1·25 lb Aurofac 2A supplies 4·5 g aureomycin) and Terramycin Feed Supplement T.M.5 (0·9 lb T.M. 5 supplies 4·5 g terramycin). Antibiotics may only be used in scientific investigations or, on the farm, under veterinary prescription. For regulations regarding their use see page 5.

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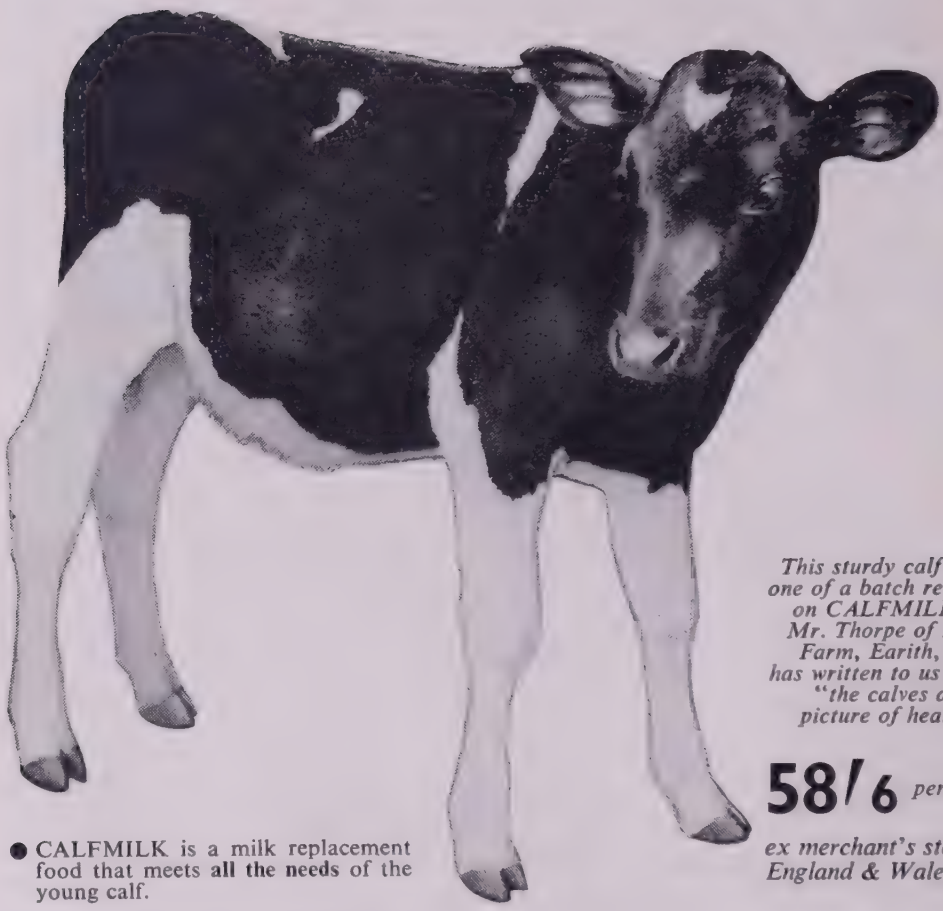

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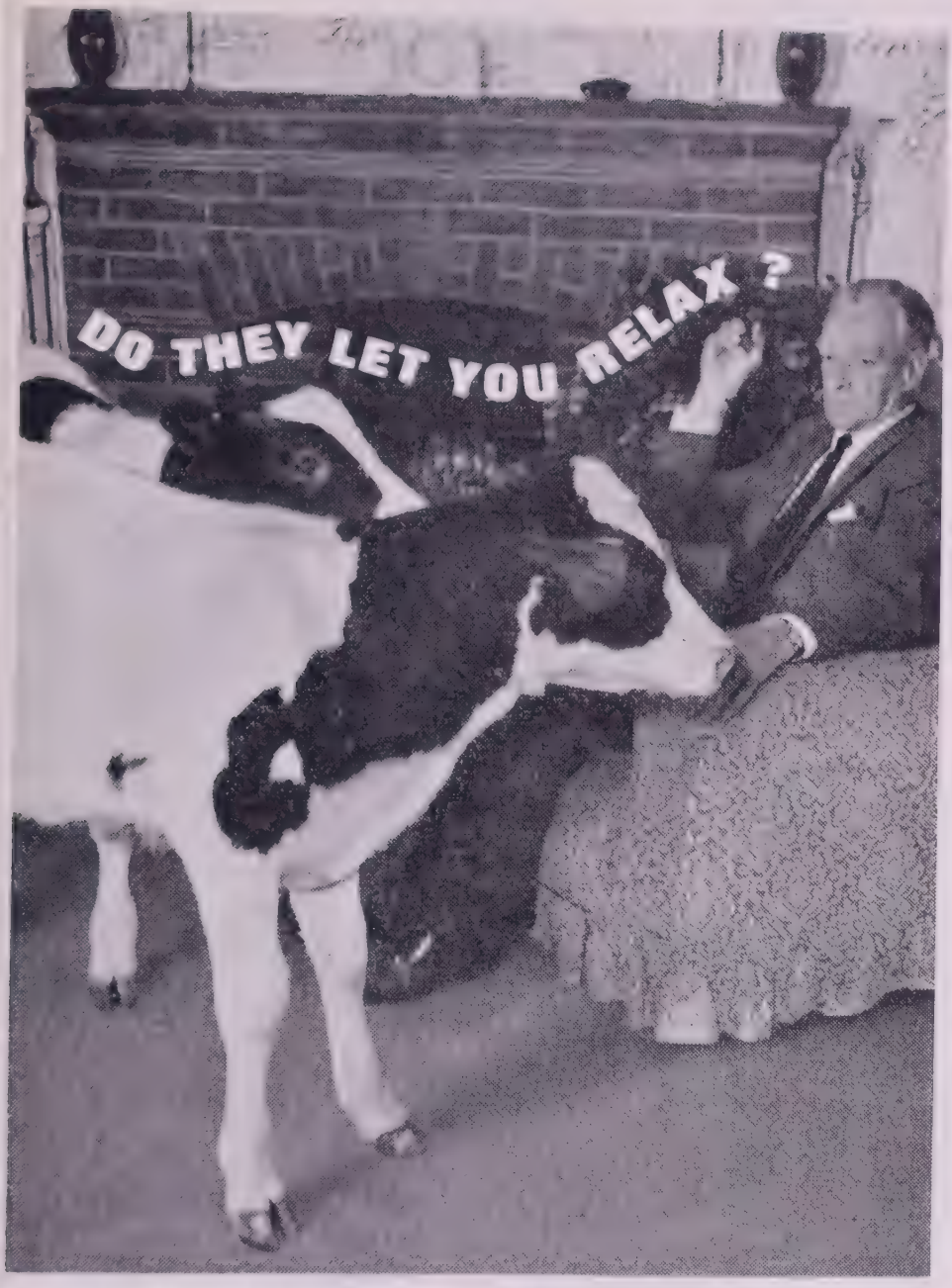

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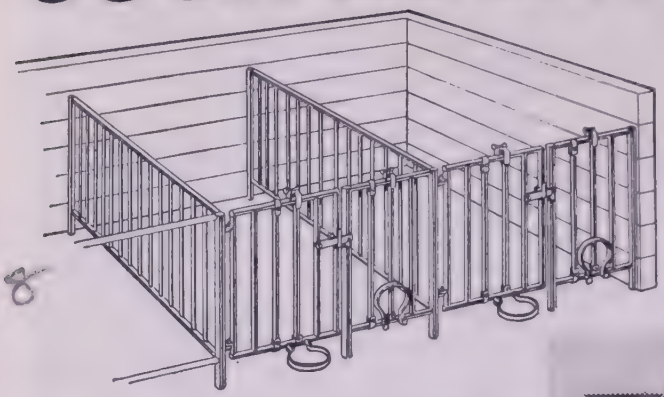

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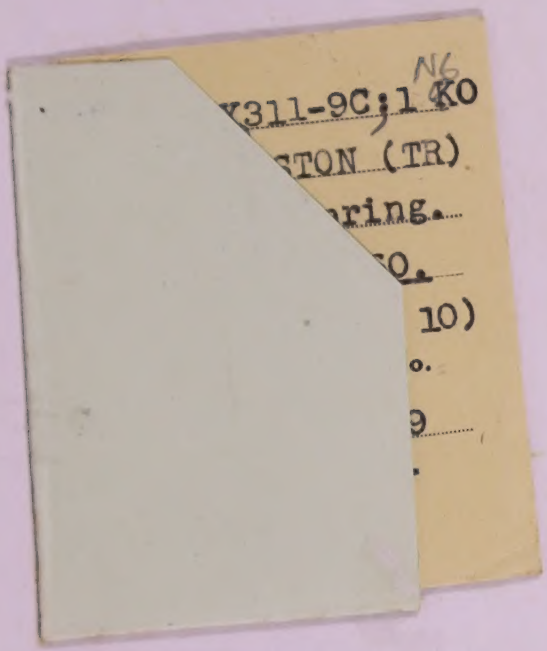
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